RHIC 2012 Ion Run: C-AD Report

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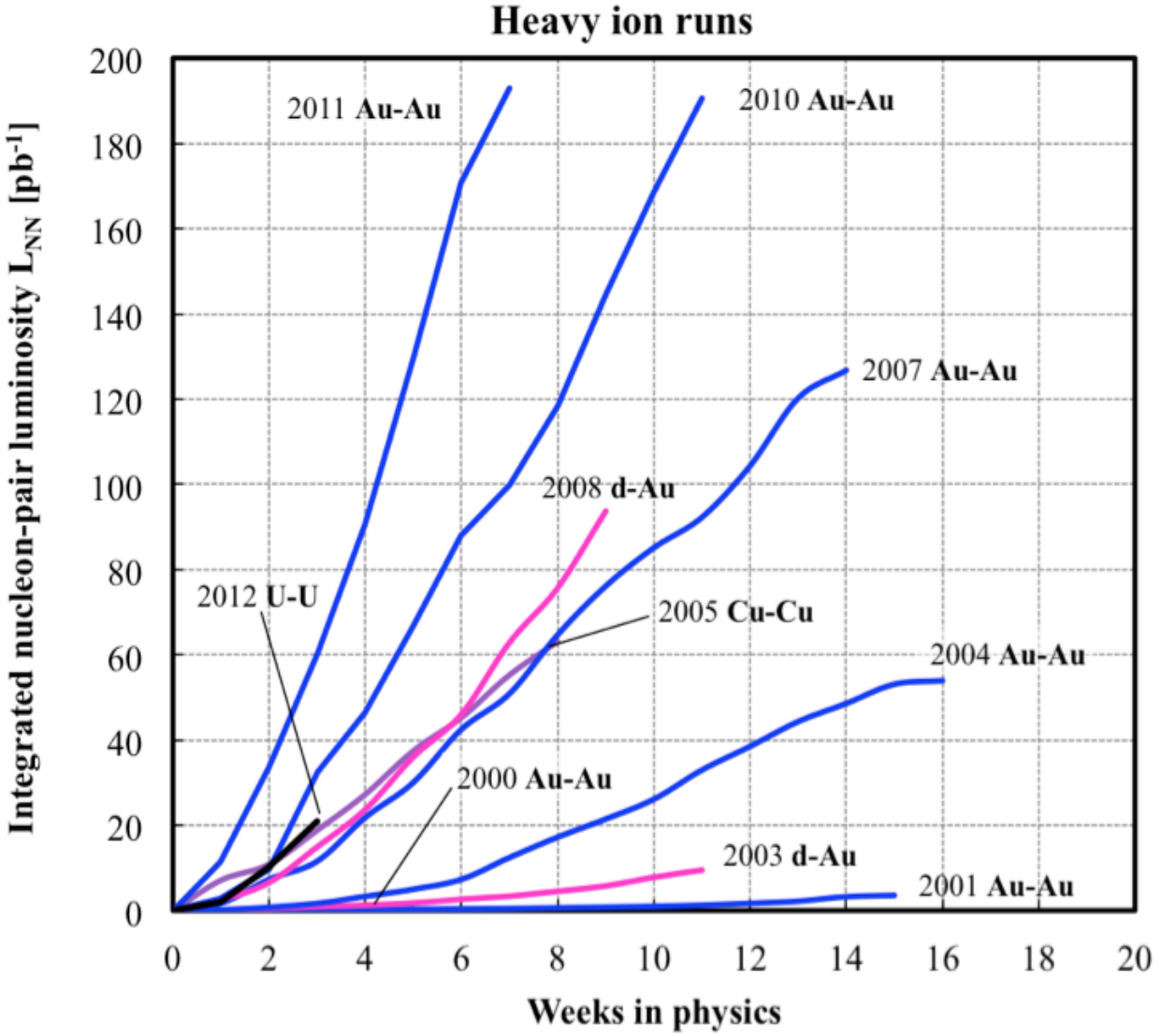
RHIC Heavy Ion Runs

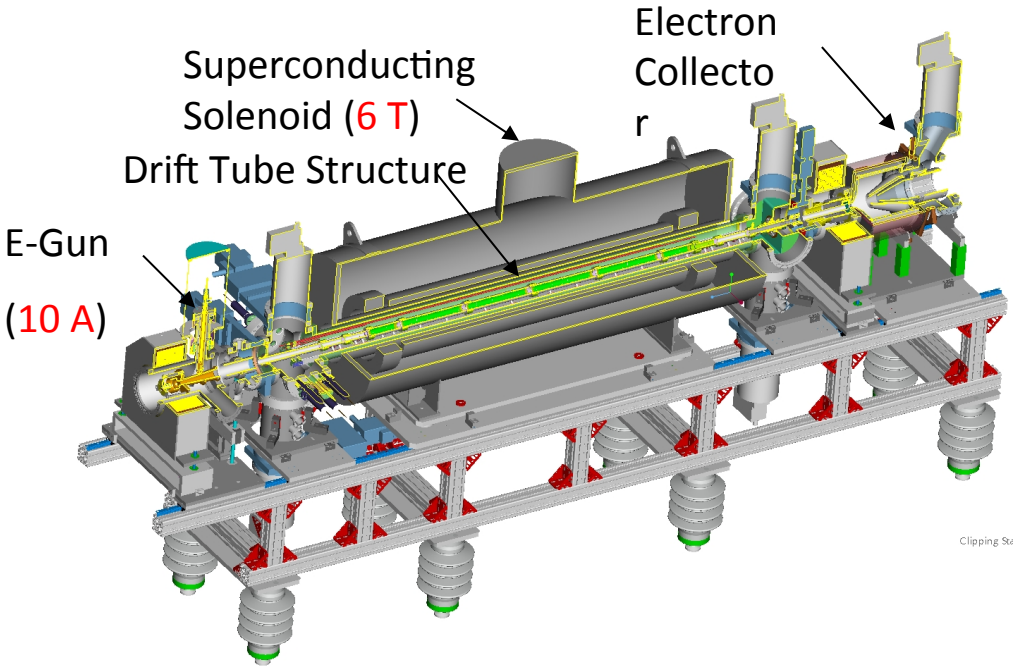


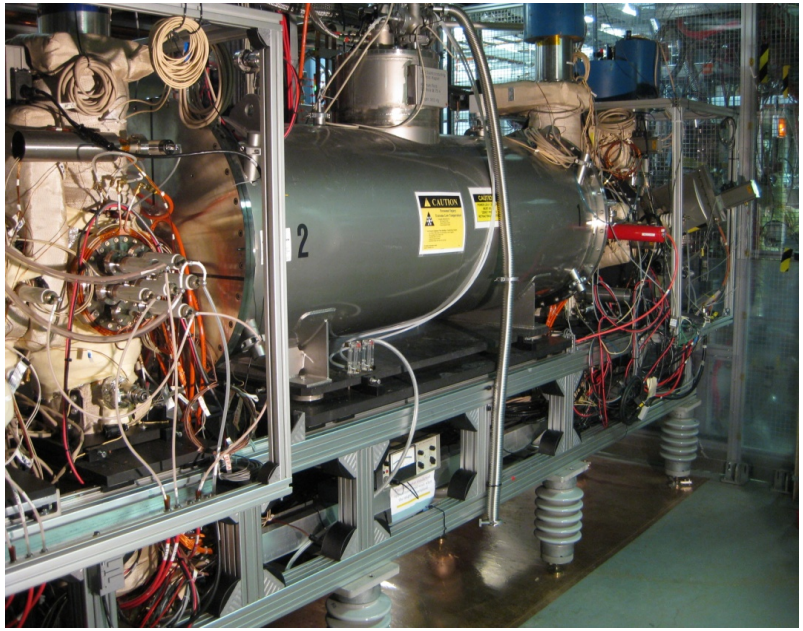
2012: first time for RHIC to collide U-U and Cu-Au.

U-U 193GeV run:
- April 19 -- May 15
- 5 day setup
- 2.9 weeks of Physics

Cu-Au 200GeV run:
- May 16 — June 25
- 4 day setup
- 5.5 weeks of Physics

Electron Based Ion Source (EBIS)

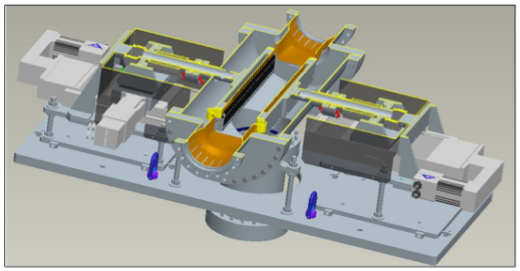


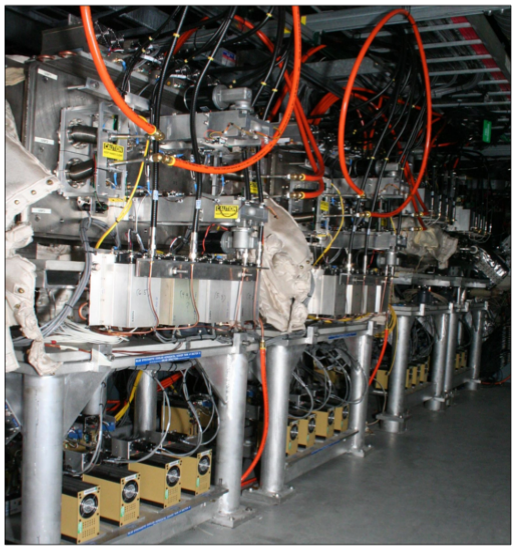


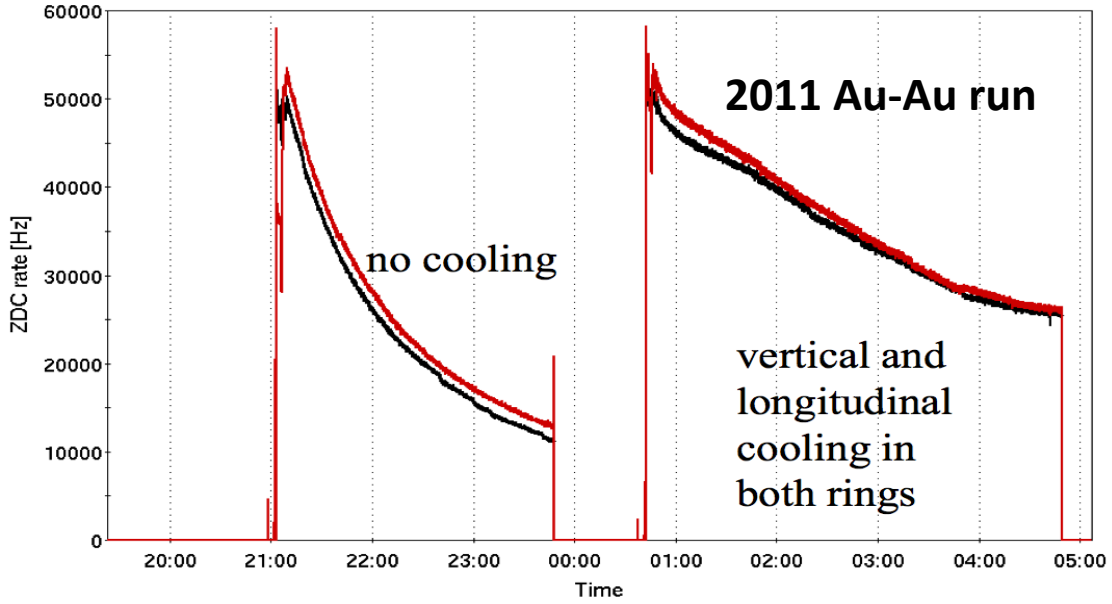
Advantages of EBIS:

- Increased flexibility to handle the simultaneous needs of RHIC and NASA (fast switching between species)
- Capability to provide ions not presently available from Tandem, such as noble gas ions (for NASA), uranium (RHIC).
- Simpler technology, robust, more modern
- Elimination of two stripping stages and an 860 m long transport line, leading to improved performance (stability, easier tuning).

3-D Stochastic Cooling



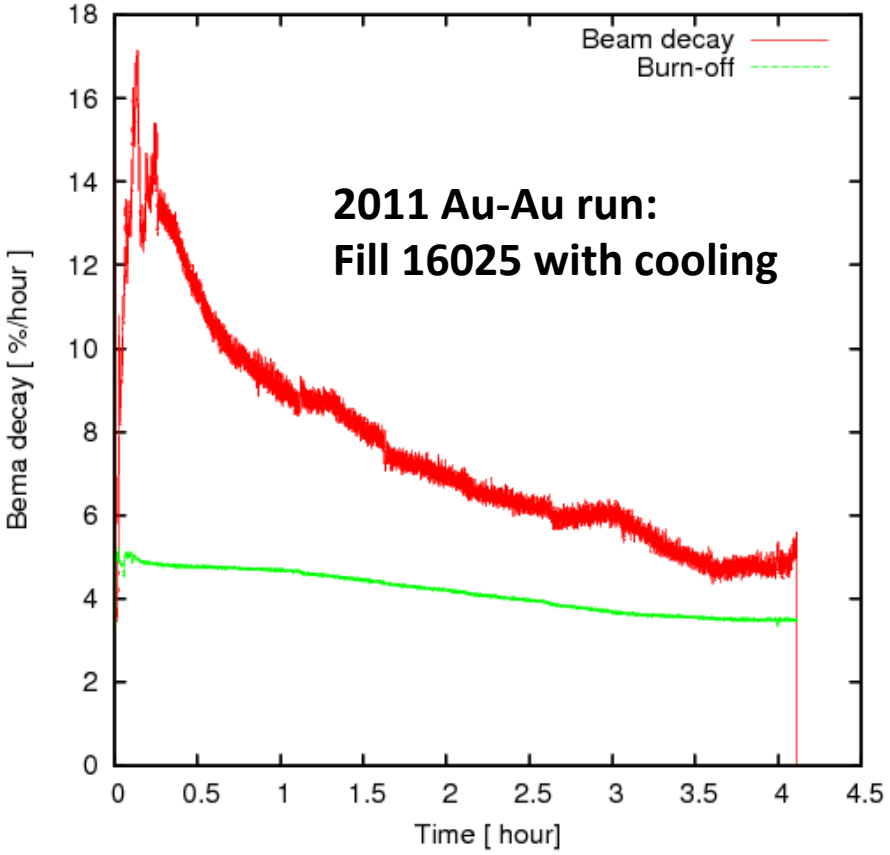


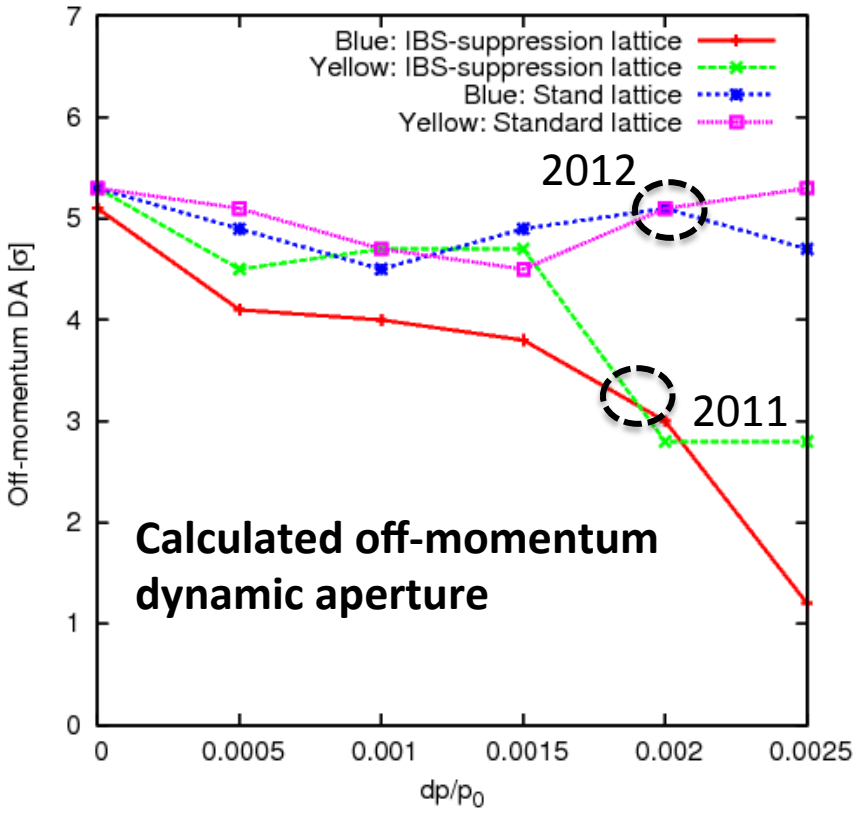


In the RHIC heavy ion runs, intrabeam scatter (IBS) increases bunch length and transverse emittances and therefore it reduces the luminosity.

To counter IBS effect, longitudinal Stochastic cooling was first implemented in 2007. In 2011, longitudinal and vertical cooling in both rings became operational. In 2012, horizontal cooling became available and full 3-D are operational.

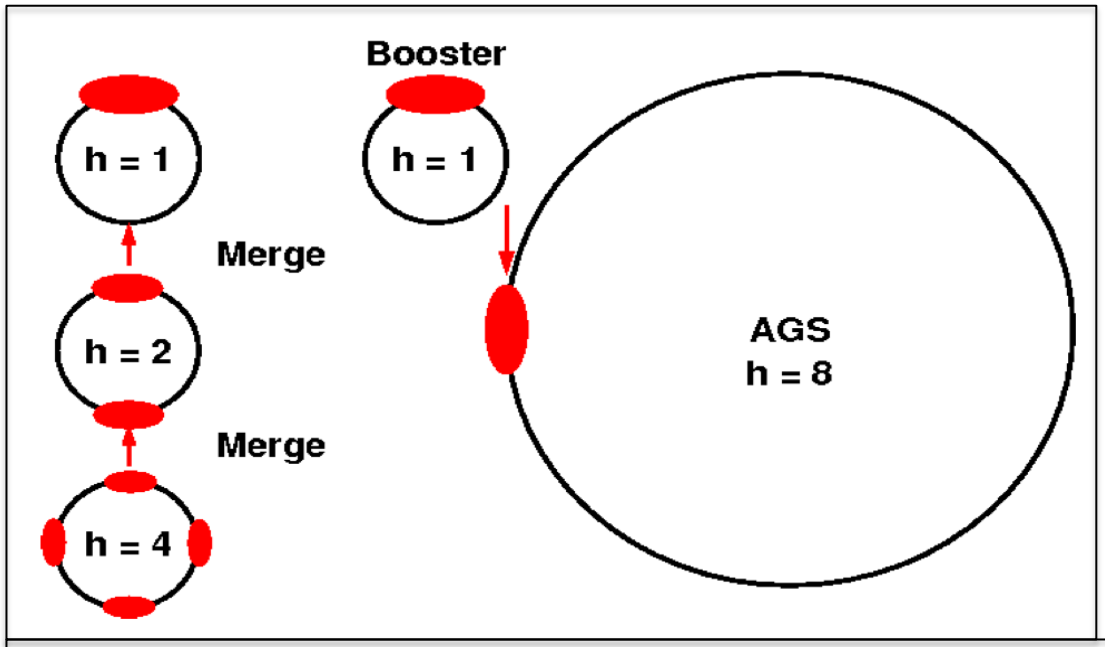
Lattice: Larger Momentum Aperture



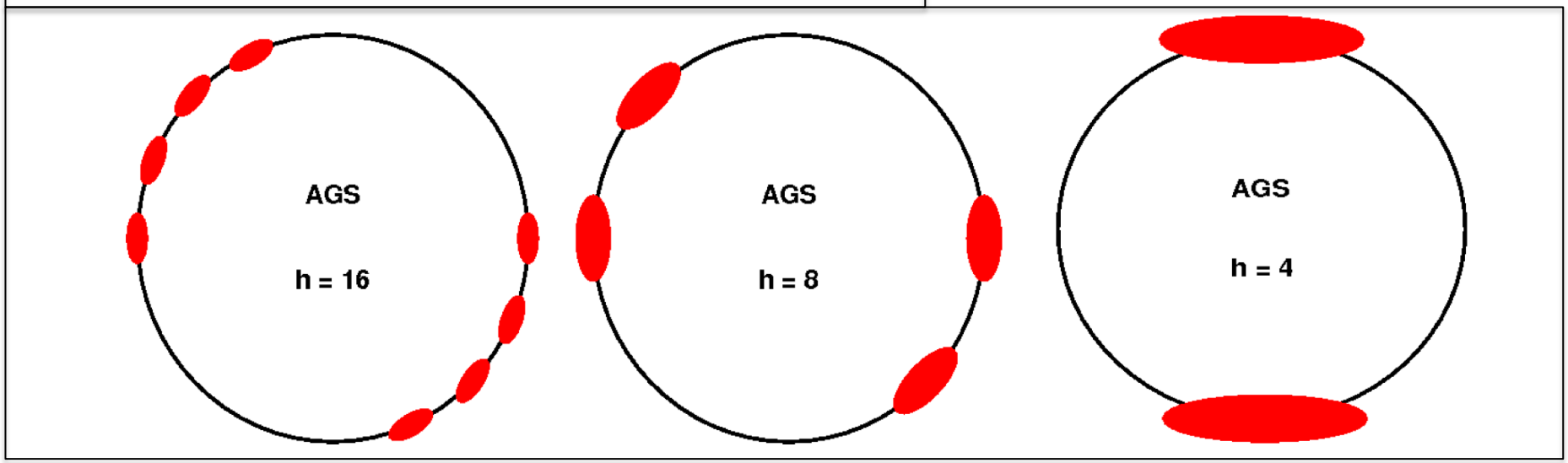


In the past Au-Au runs, large beam loss were observed at RF re-bucketing and in store. The beam loss was dominated by the particles with larger momentum deviation. In 2012 we adopted a lattice with a much larger momentum aperture.

Bunch Merging: Increasing Bunch Intensity



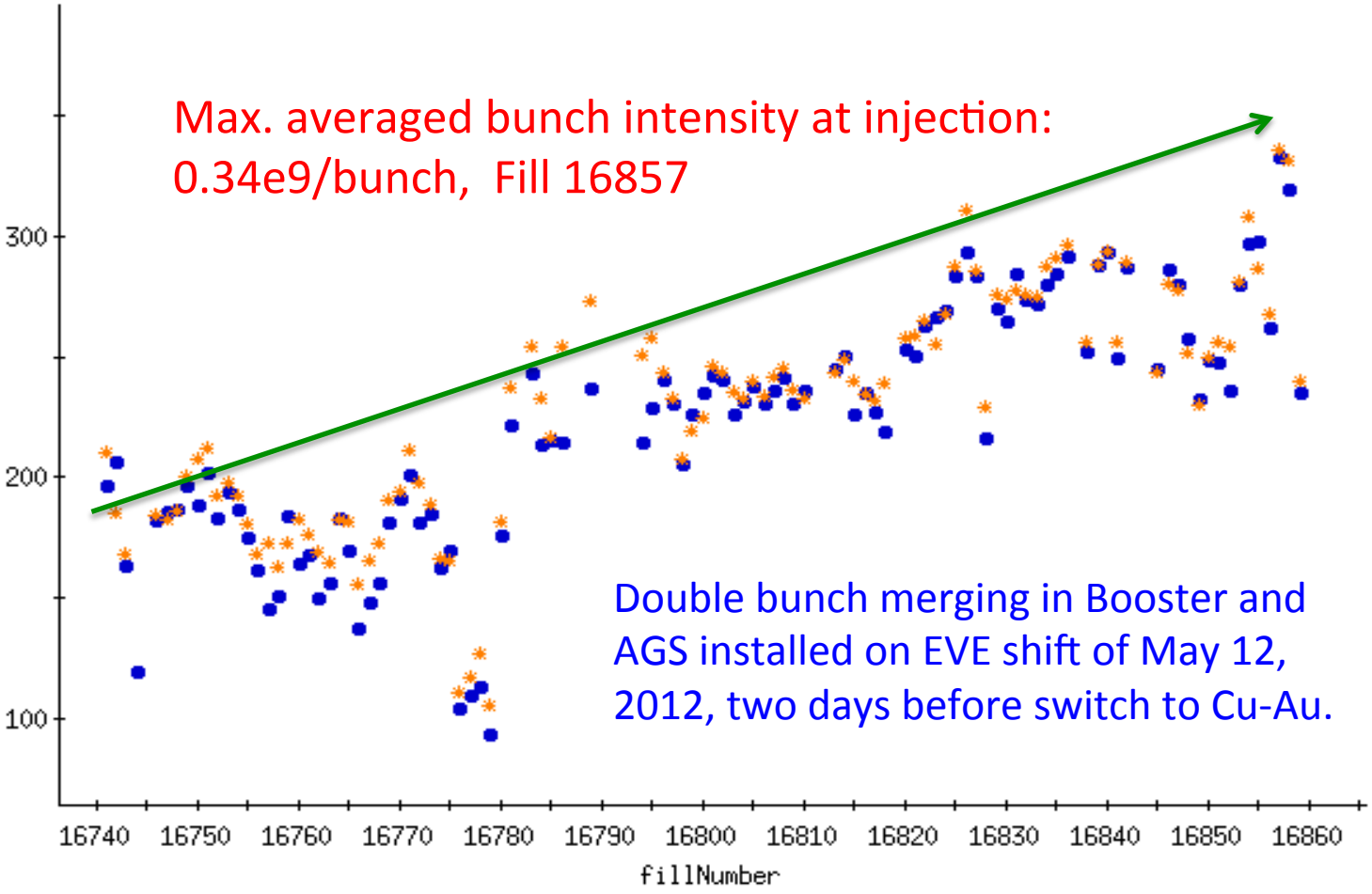
Bunch merging in Booster and AGS is implemented to increase RHIC bunch intensity.



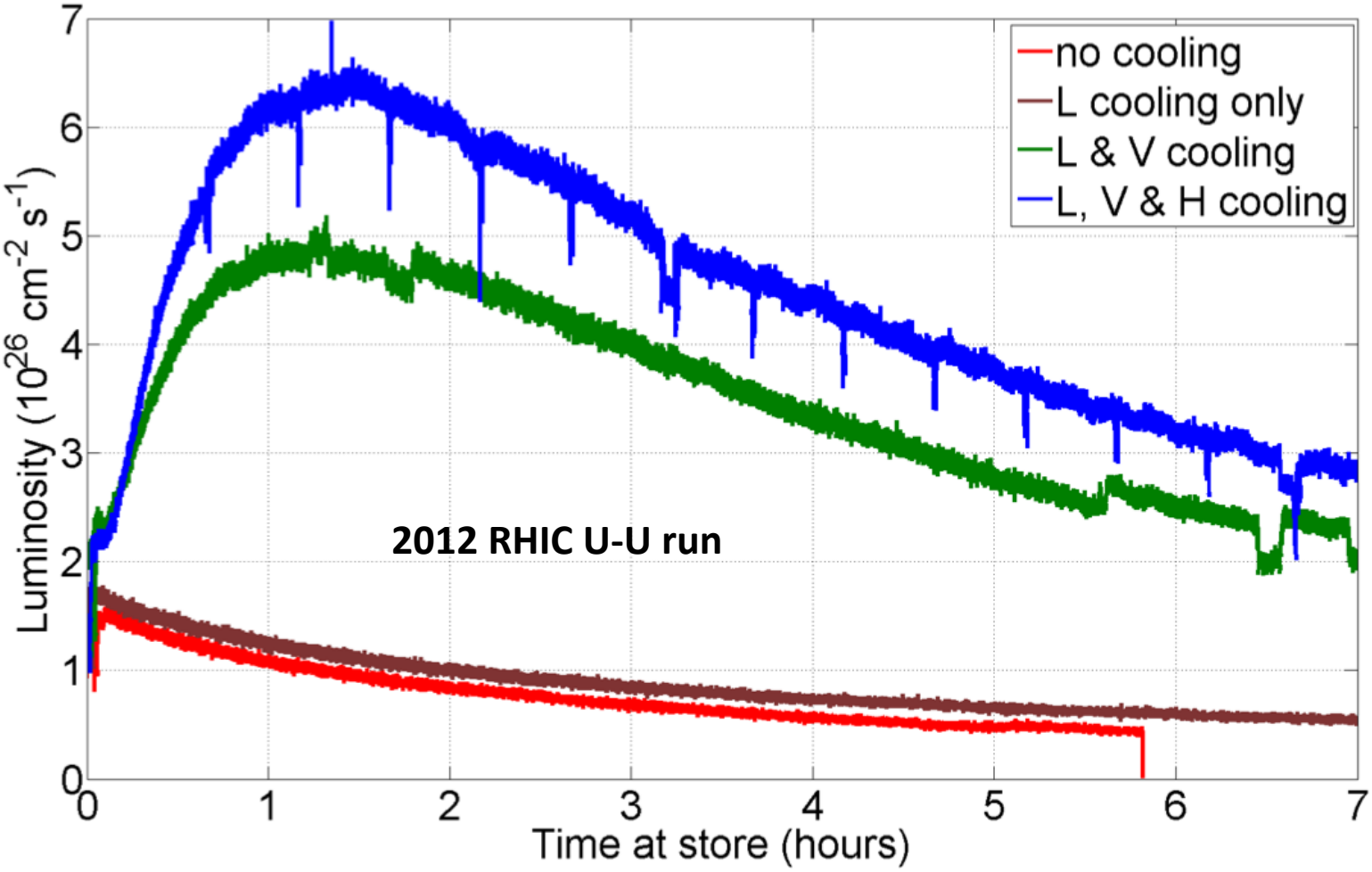
Start-up of U-U Run

	THR (April 19)	FRI (April 20)	SAT (April 21)	SUN (April 22)	MON (April 23)	TUE (April 24)
OWL	Beam Experiment with proton	Established circulating beams	BoosterA MM PS tripped off	Ramp develop ment	First 2 overnight stores	ramp develop. 1 store
DAY	Pre-beam Set-up PS flip RF work	RF capture Bunched beam	re-bucketing RF hardware setup	Ramp develop ment	EBIS vacuum repairing	RF re-bucketing
EVE	AtR tuning AtR synchro	First successful ramp	re-bucketing RF hardware setup	Store tuning	EBIS vacuum repairing	Fine tune store Physics declared

RHIC Uranium Bunch Intensity

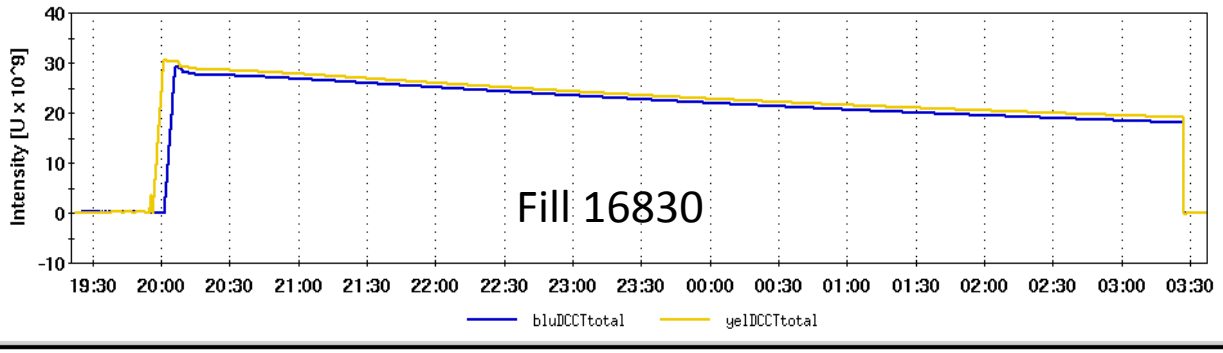


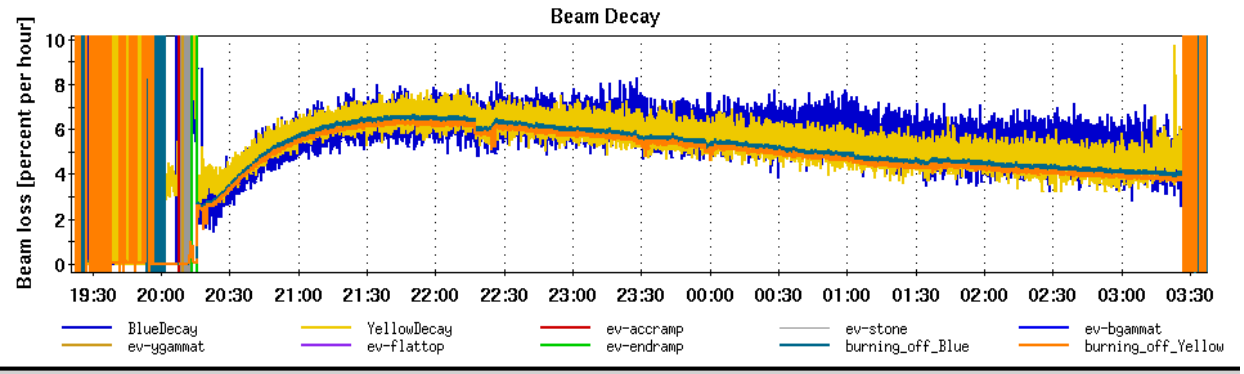
Luminosity with Stochastic cooling

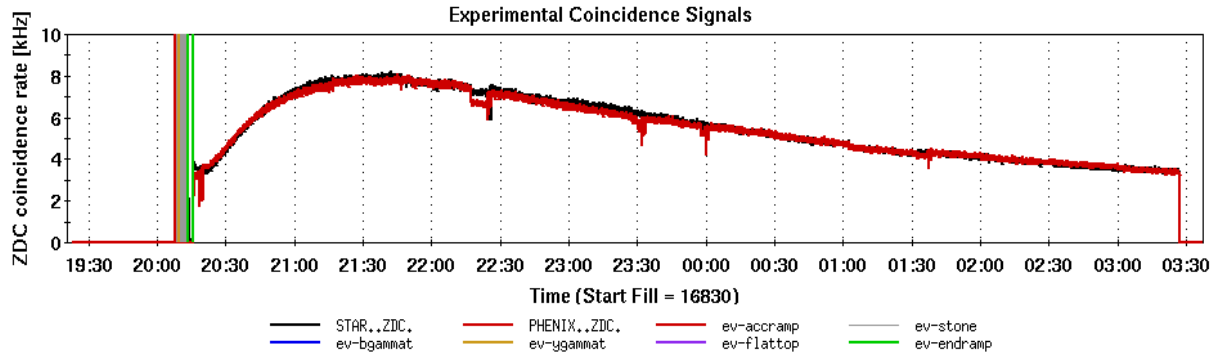


With 3-D cooling on, peak luminosity far exceeds the initial luminosity. Integrated luminosity per store is about 5 times of that without cooling.

An Ultimate Collider

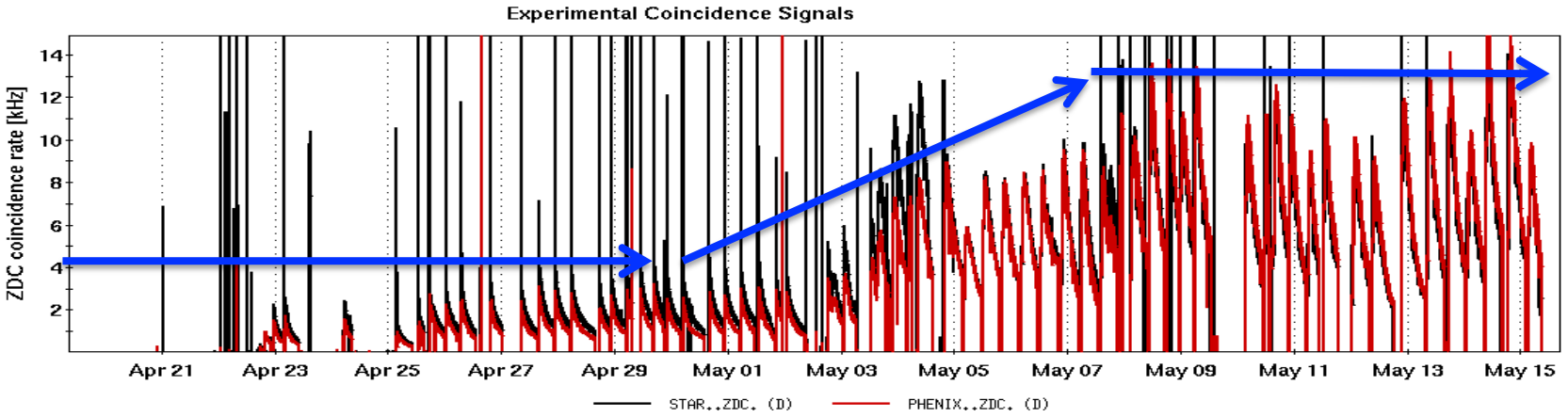


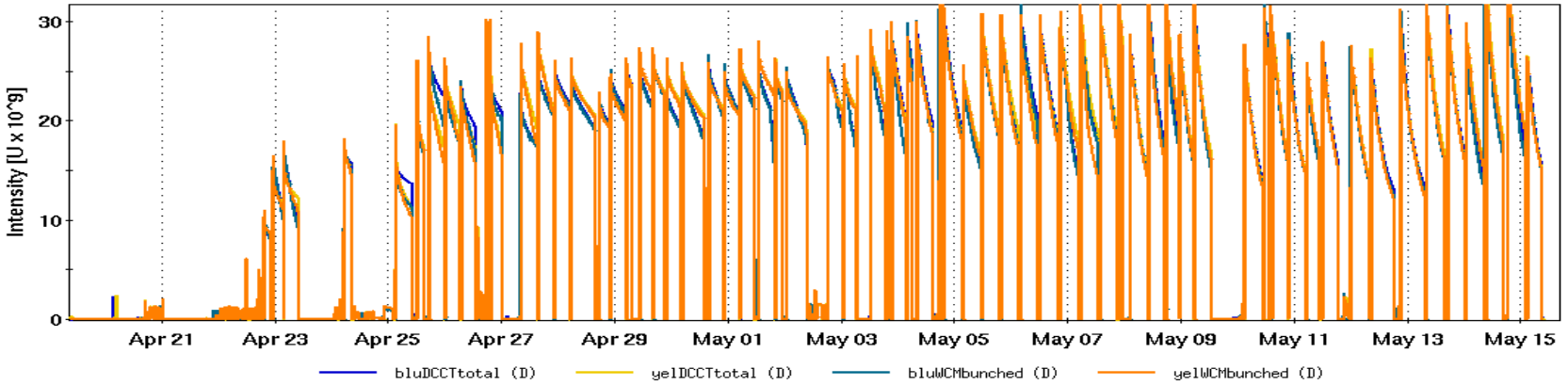




Thanks to enlarged off-momentum dynamic aperture and Stochastic cooling, the beam loss in the Physics stores is entirely from luminosity burn-off.

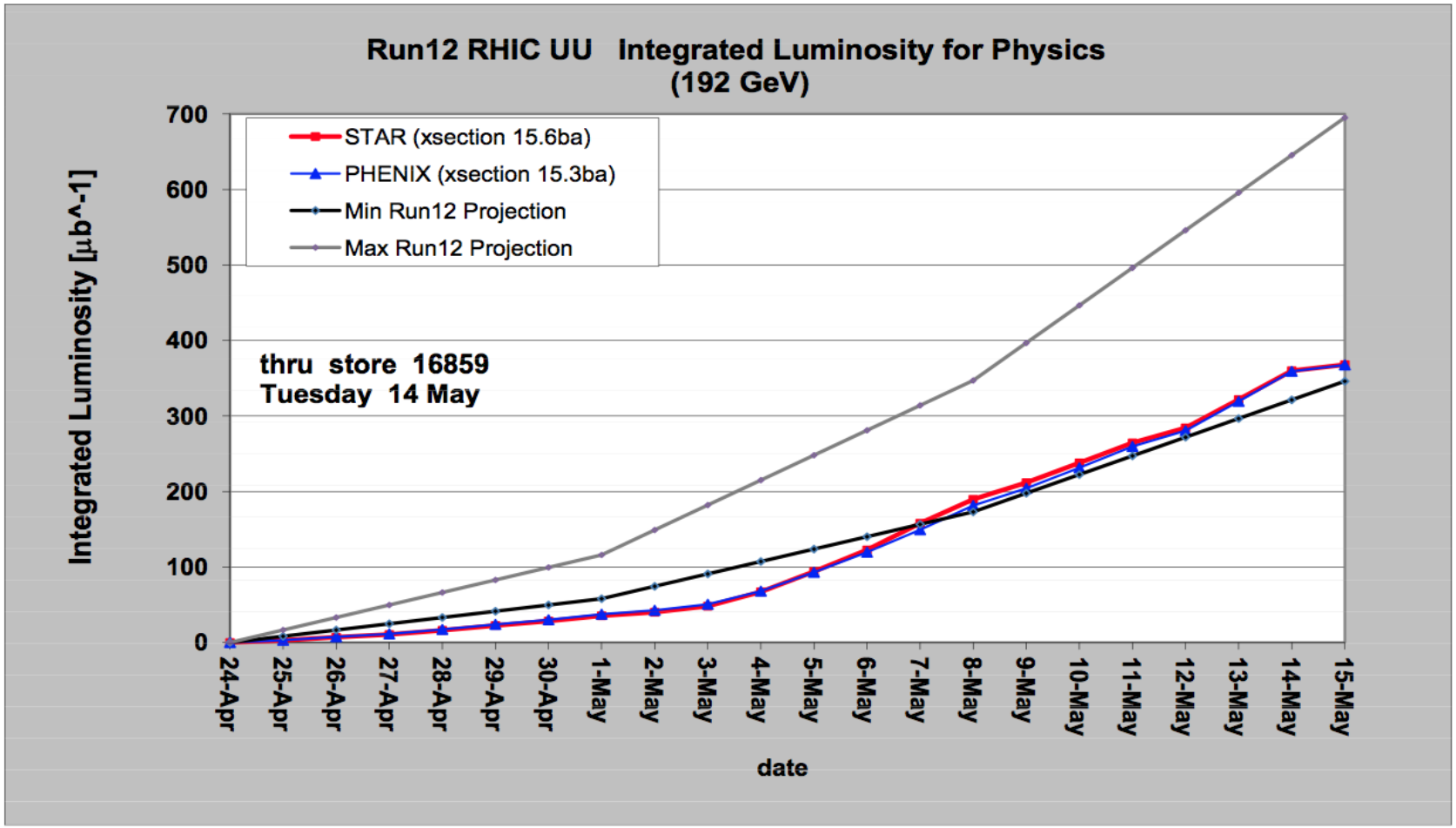
2012 U-U Run Journey





3-D stochastic cooling on in both ring since May 07, 2012. Bunch merging installed in AGS on May 12, 2012. The 2012 U-U run store time is 70% of the calendar time.

Integrated Luminosity (C-AD)

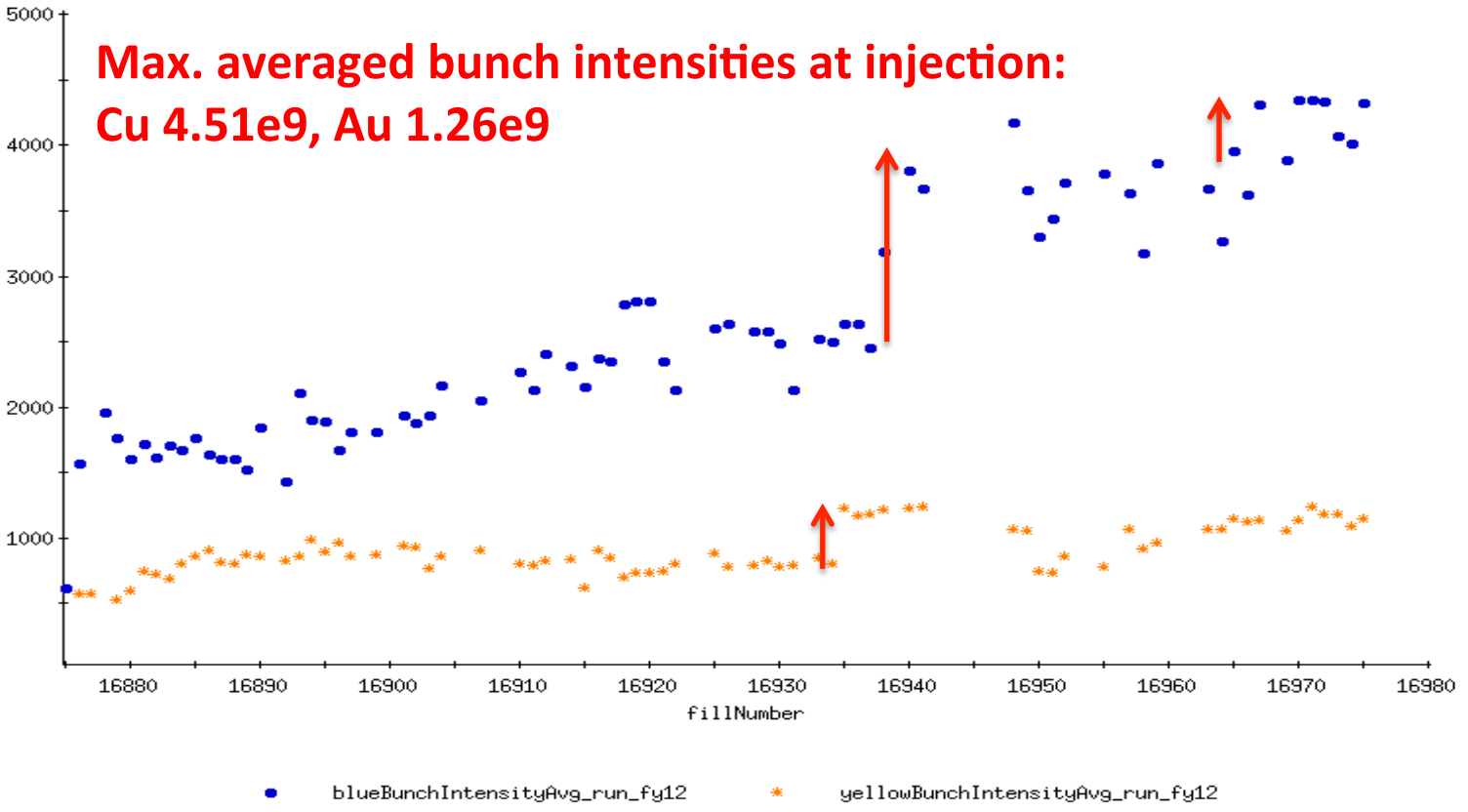


Phenix reached their integrated luminosity goal two days early.
Star reached their goal just before the beam dump of the last store.

Start-up of Cu-Au Run

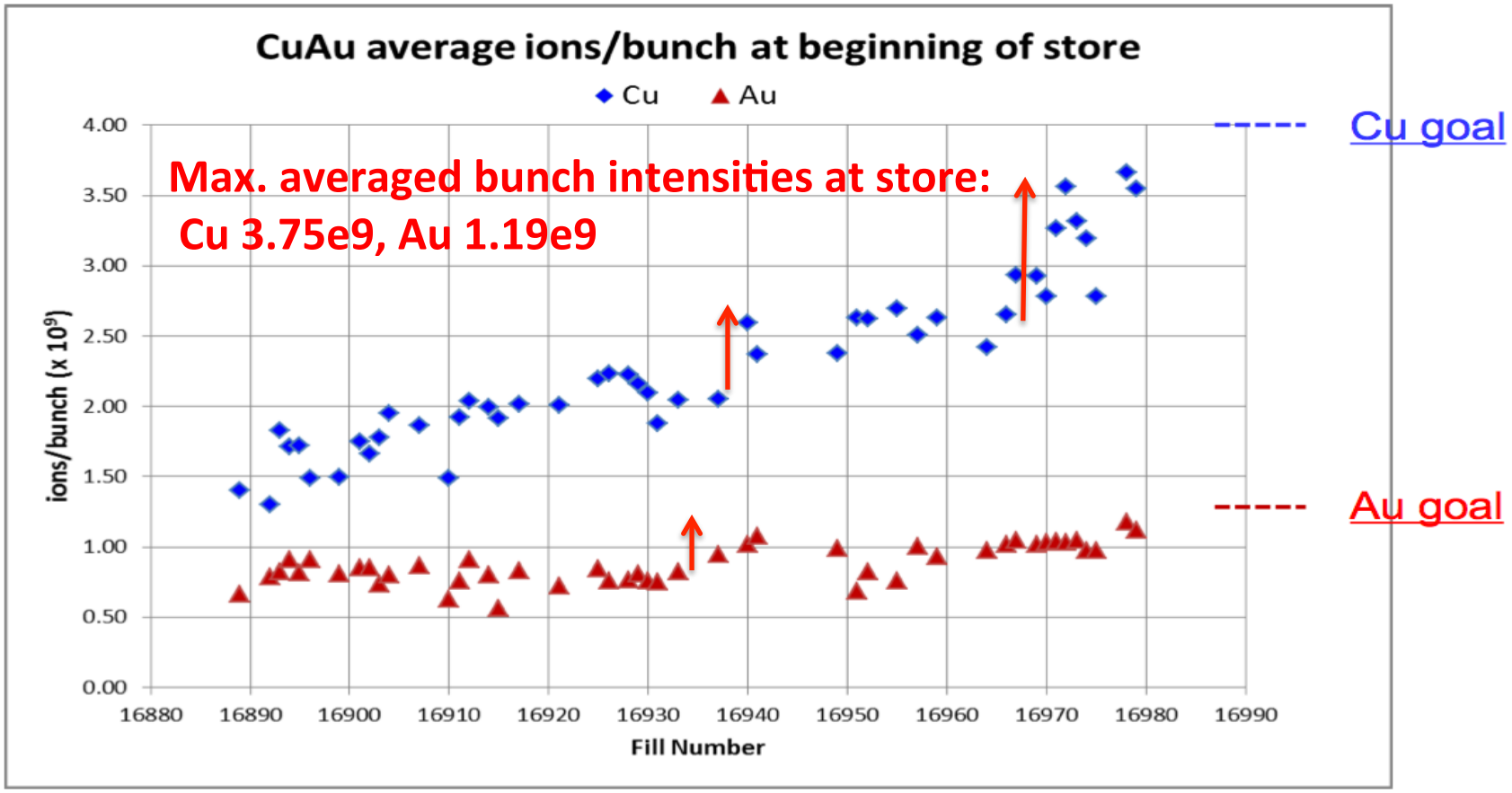
	TUE	WED	THU	FRI
OWL	Last fill of U Replace U source Last store of U	No Au beam Blue only ramp development	No Au beam Ramp develop. Blue beam only	First store for detector setup
DAY	Switch to Cu-Au Control setup PS/ RF work	No Au beam Blue only ramp development Blue store tuning	Ramp develop. Both beams	Cooling setup
EVE	Cu beam injection Cu beam circulating Cu RF Capture	Au came Au circulated RF capture	Store tuning Collimation Background	Physics stores begin

Pushing RHIC Bunch Intensity



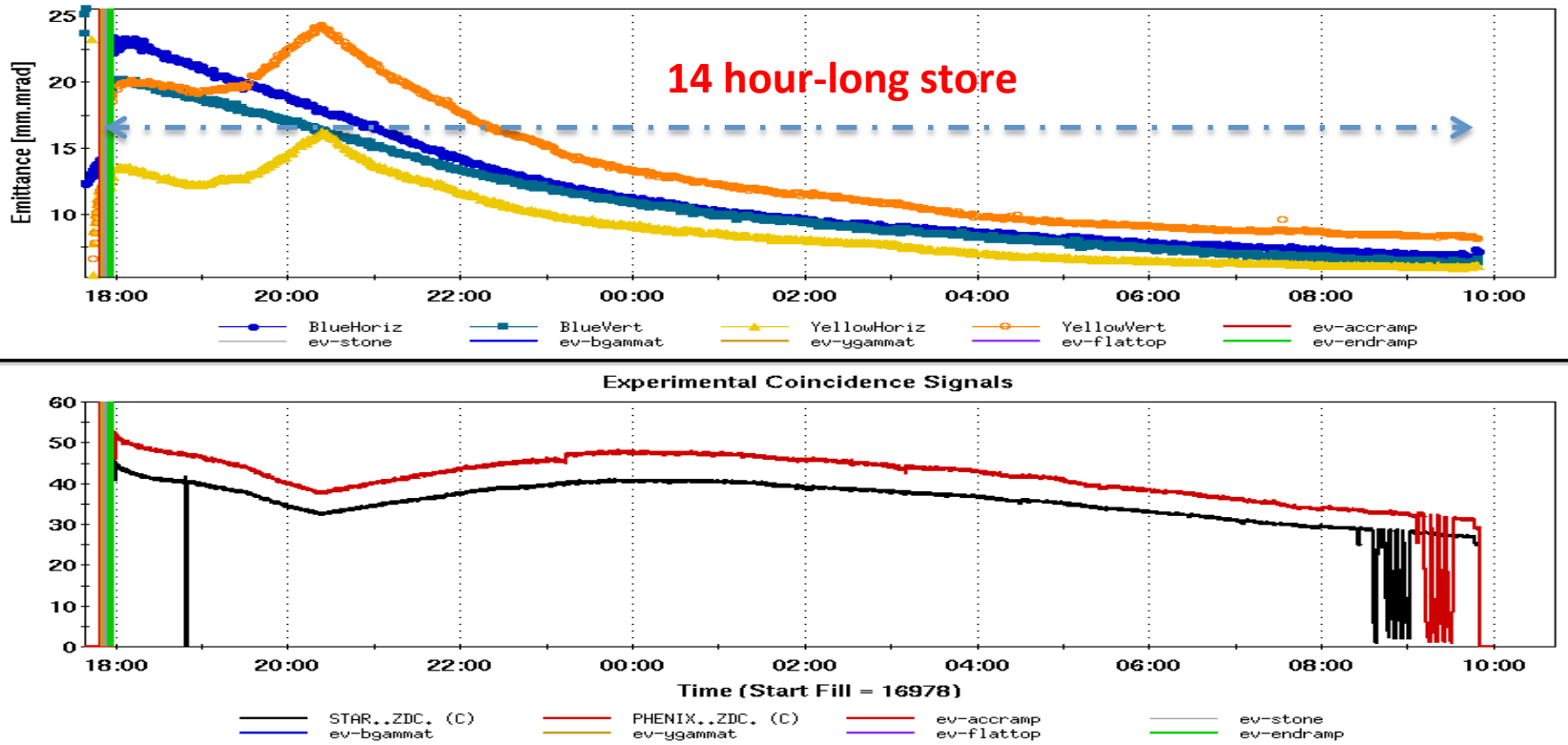
- Au bunch intensity improved by fine tuning the AGS-to-RHIC (AtR) transfer lines.
- Cu bunch intensity improved by using Neon instead of Argon gas in EBIS and fine tuning AtR transfer line.

Improving Ramp Efficiency



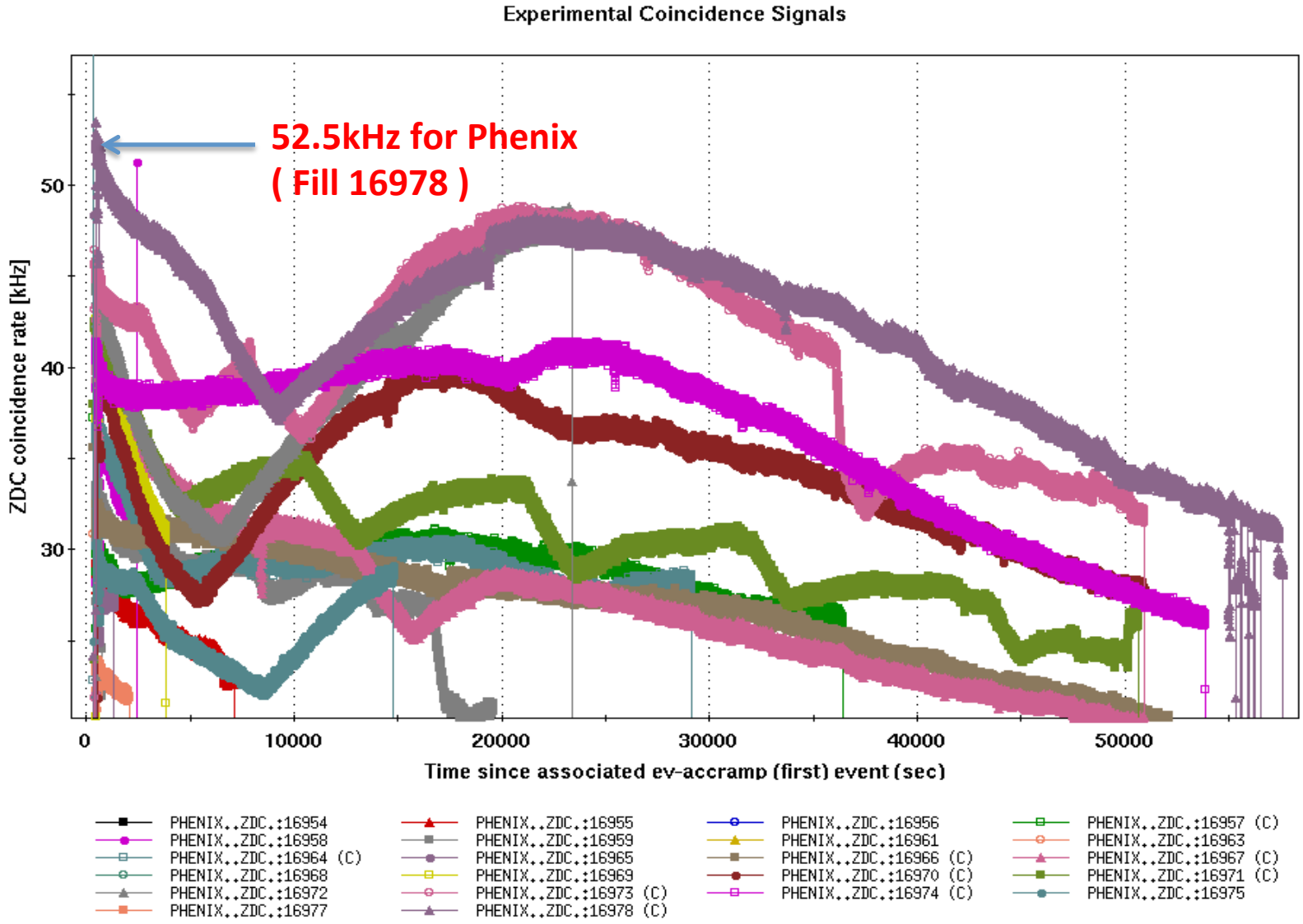
To send more bunch intensities to store, we continued improving the energy ramp efficiencies by adjusting chromaticity settings, applying octupole strengths, and tune set point adjustment on the ramp.

Maximizing Integrated Luminosity

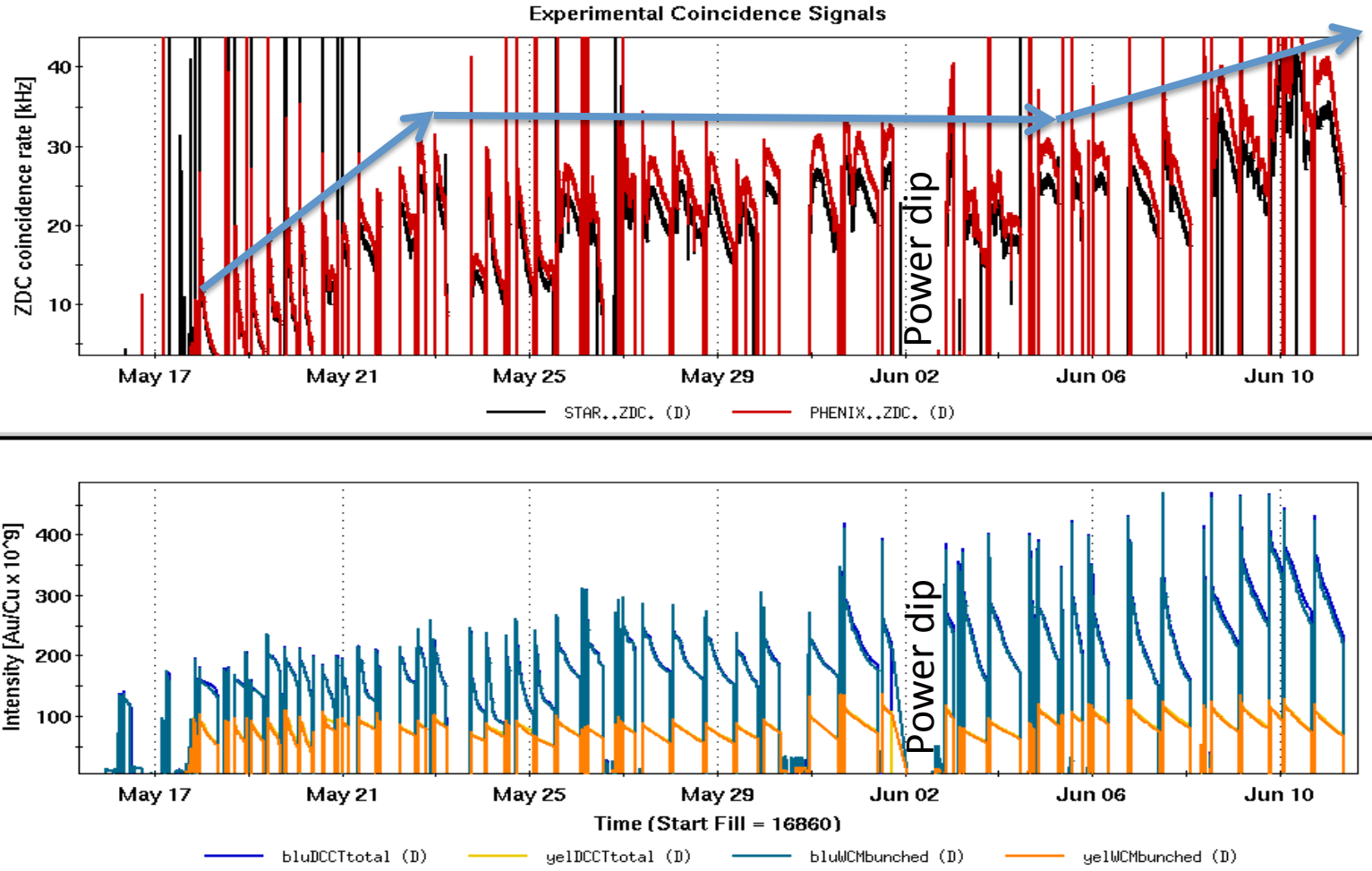


- The initial emittances of the Cu beam are much larger than the yellow beam. Also Stochastic cooling speed is inversely proportional to the particle number per bunch so that it is harder to cool Cu beam than Au beam.
- To maximize the integrated luminosity we applying different cooling rates in the beginning, middle, and end of a store.

The Best Cu-Au Store To Date

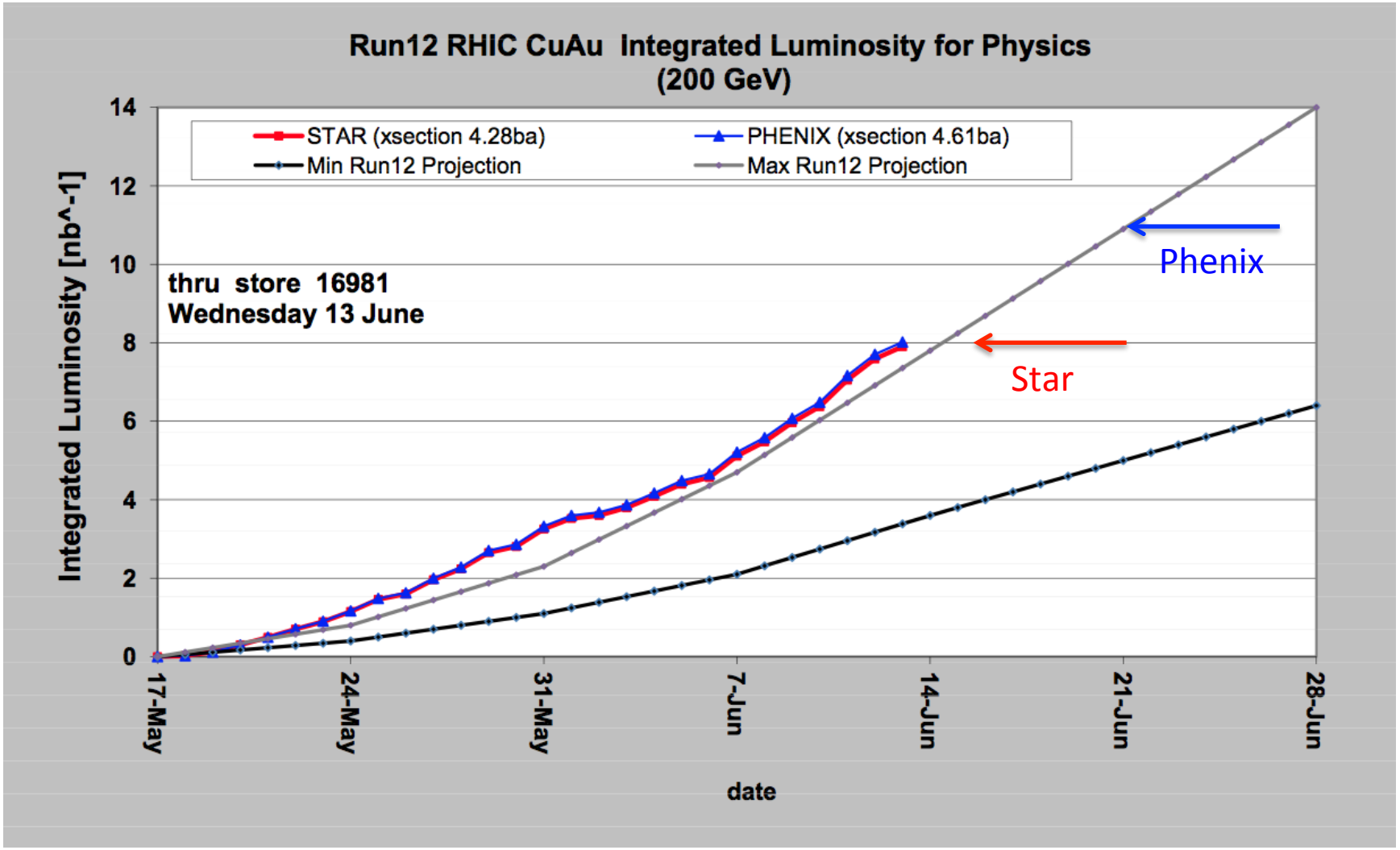


2012 Cu-Au Run Journey



First wave of luminosity increase comes from Stochastic cooling. Second wave comes from increased bunch intensity and improved ramp efficiency.

Integrated Luminosity (C-AD)



Summary

- 2012 U-U is a miracle. We reached the luminosity goal with excellent Stochastic cooling although the bunch intensity in RHIC is lower than its projection.

- 2012 Cu-Au run is currently running above optimistic projections. The Phenix's integrated luminosity goal will be reached before June 25 if there is no major machine down time.